SEMICONDUCTOR DEVICE AND METHOD OF MANUFACTURING SAME

insert → This application is a DIV of 09/520,959 filed 03/08/2000, abandoned.

CROSS REFERENCE TO RELATED APPLICATIONS

The subject application is related to subject matter disclosed in Japanese Patent Application No. Hei 11-62295 filed on March 9, 1999 in Japan to which the subject application claims priority under the Paris Convention and which is incorporated herein by reference.

QL 2/8/05

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a semiconductor device having a BPSG (boron-doped phosphorus silicate glass) interlayer insulating film, and particularly, to a method of minimizing the oxidization of a semiconductor substrate and gate electrode during a reflow process.

2. Description of the Related Art

When forming highly-integrated semiconductor devices, it is necessary to minimize the extension of diffusion layers by carrying out a heat treatment at a low temperature within a short time. The highly-integrated semiconductor devices employ fine design rules, and therefore, interlayer insulating films of high aspect ratios must be formed for them without voids. To achieve this, the interlayer insulating films are usually made of BPSG. A BPSG film is easy to carry out a reflow process thereon at a low temperature within a short time. The reflow process is usually carried out in a water vapor atmosphere to decrease the temperature and time of the reflow process. The water vapor atmosphere, however, oxidizes semiconductor regions and gate electrodes, or thickens and varies gate insulating films, or thins and varies the gate electrodes. In addition, hydrogen (H) in the water (H_2O) vapor atmosphere diffuses into gate oxide films, to deteriorate the reliability of the gate oxide films.

Figure 1A is a sectional view showing a semiconductor device before a reflow process. The semiconductor device consists of a silicon substrate 1 on which a gate electrode is formed. A BPSG film is formed on the gate electrode. More precisely, a silicon oxide film 2 serving as a gate insulating film is formed on the substrate 1. On the film 2, there is a lamination of a polysilicon film 3 and a tungsten silicide (WSi_2) film 4 serving as the gate electrode. On the film 4, there is an oxide film 5 for protecting the gate electrode. The gate electrode is shaped by photolithography and by anisotropic etching such as reactive ion etching (RIE). The BPSG film 7 is formed over the film 5, an exposed area of the substrate 1, and the side walls of the films 2 to 4. Before forming the BPSG film 7, a